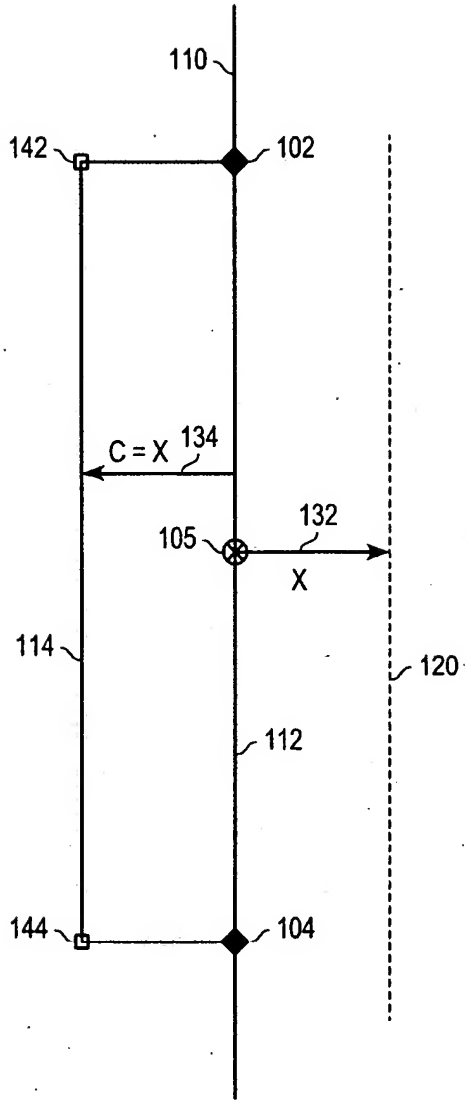


Fig. 1 (Prior Art)

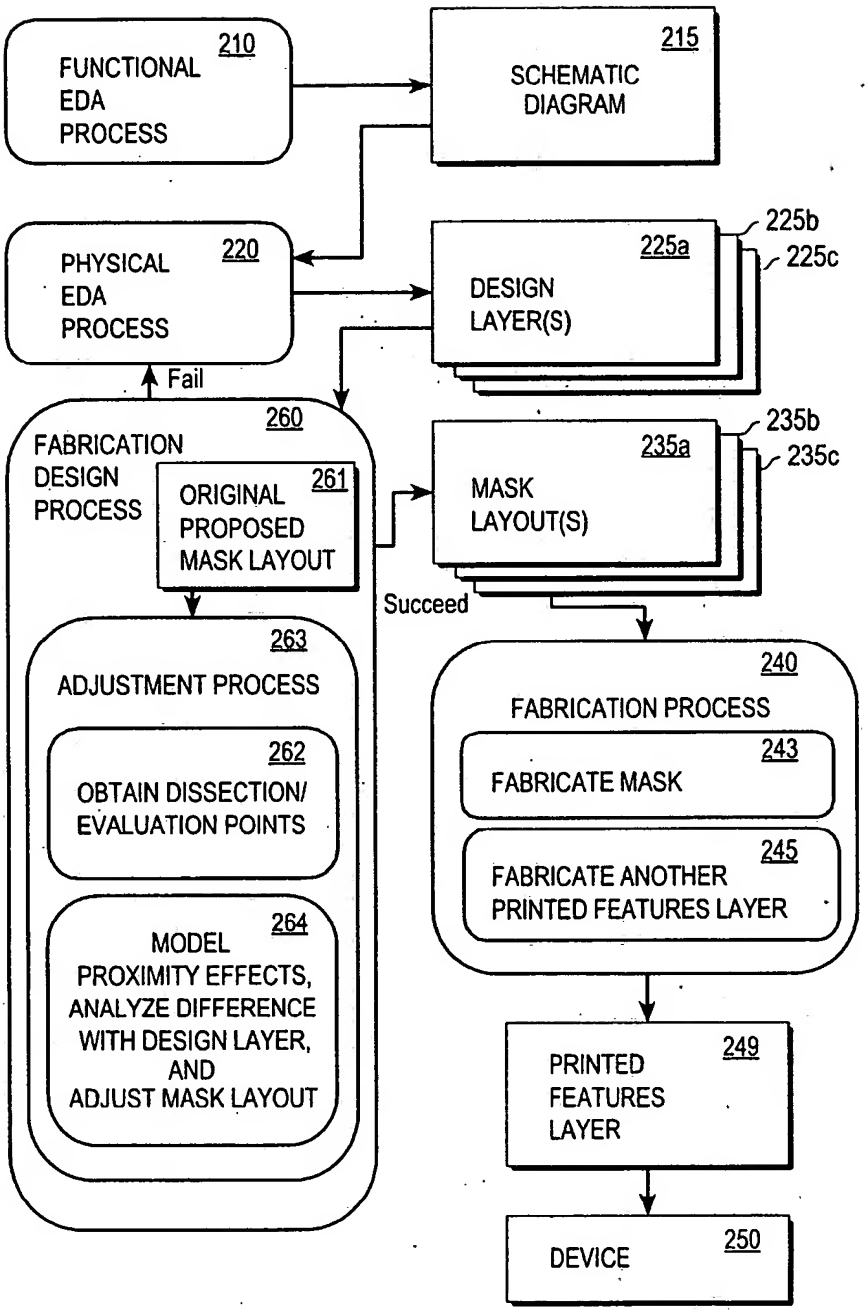

210
FUNCTIONAL EDA PROCESS
215
SCHEMATIC DIAGRAM
220
PHYSICAL EDA PROCESS
225a
DESIGN LAYER(S)
225b
225c
Fail
260
FABRICATION DESIGN PROCESS
261
ORIGINAL PROPOSED MASK LAYOUT
235a
MASK LAYOUT(S)
235b
235c
Succeed
263
ADJUSTMENT PROCESS
262
OBTAIN DISSECTION/ EVALUATION POINTS
264
MODEL PROXIMITY EFFECTS, ANALYZE DIFFERENCE WITH DESIGN LAYER, AND ADJUST MASK LAYOUT
240
FABRICATION PROCESS
243
FABRICATE MASK
245
FABRICATE ANOTHER PRINTED FEATURES LAYER
249
PRINTED FEATURES LAYER
250
DEVICE

Fig. 2

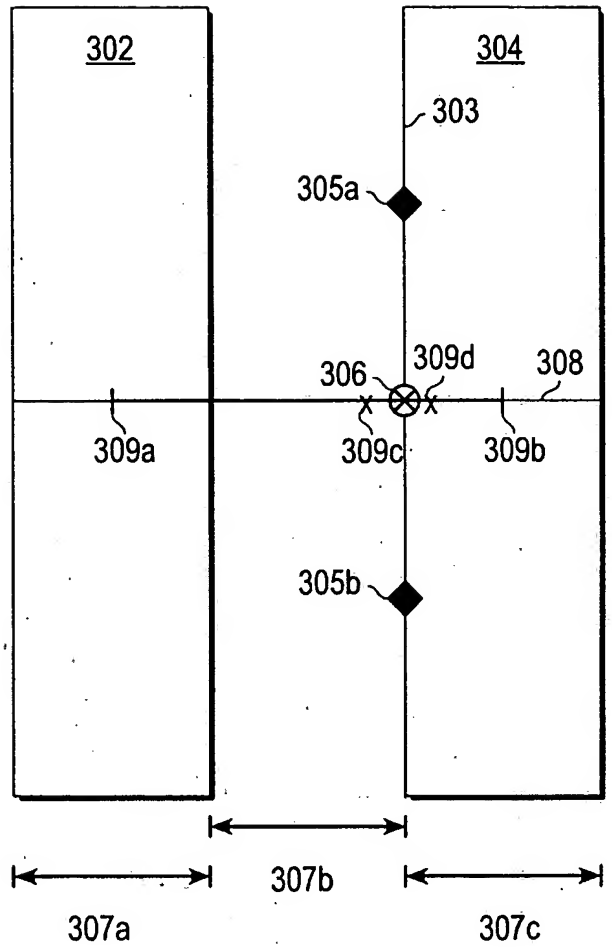

302
304
303
305a
306
309d
308
309a
309c
309b
305b
307b
307a
307c

Fig. 3A

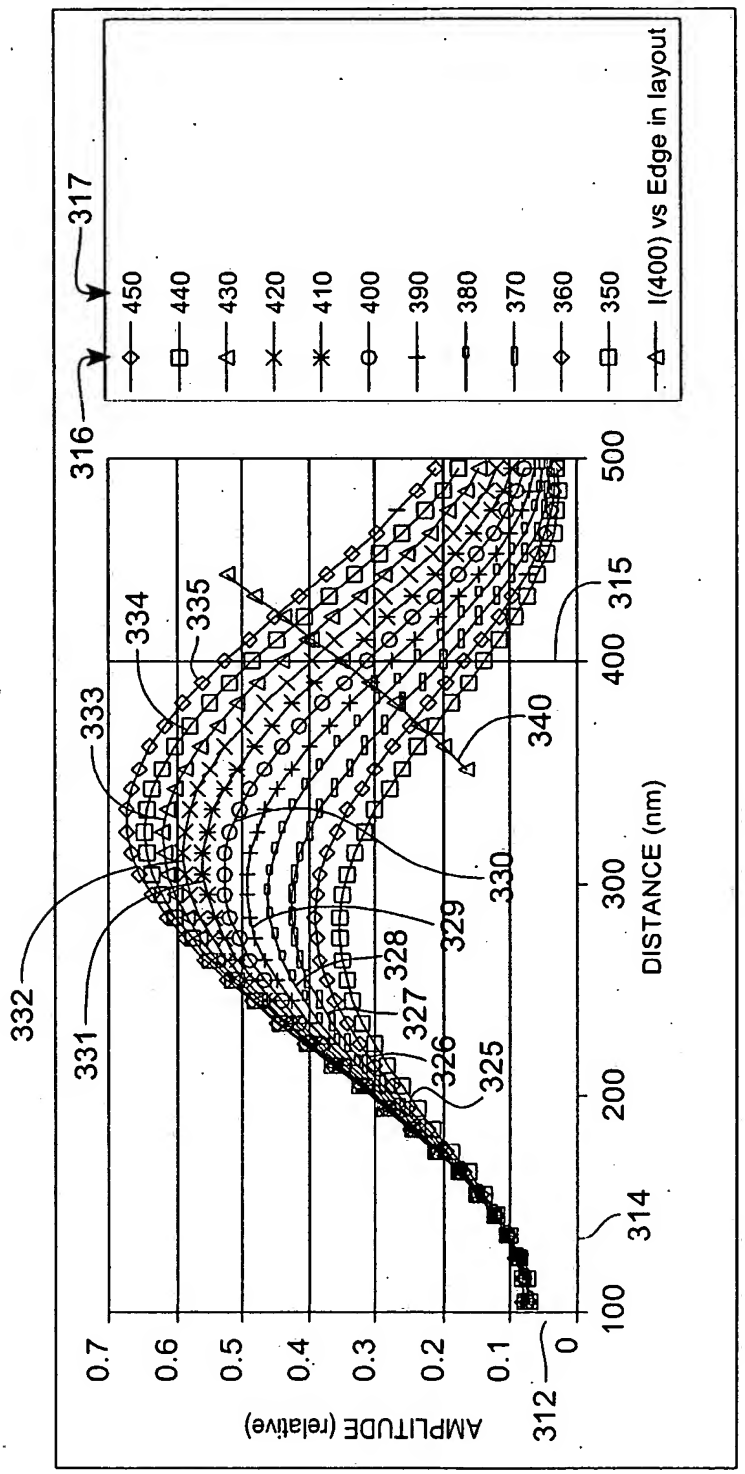

AMPLITUDE (relative)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
DISTANCE (nm)
100
200
300
400
500
I(400) vs Edge in layout
450
440
430
420
410
400
390
380
370
360
350
312
314
315
316
317
325
326
327
328
329
330
331
332
333
334
335
340

Fig. 3B

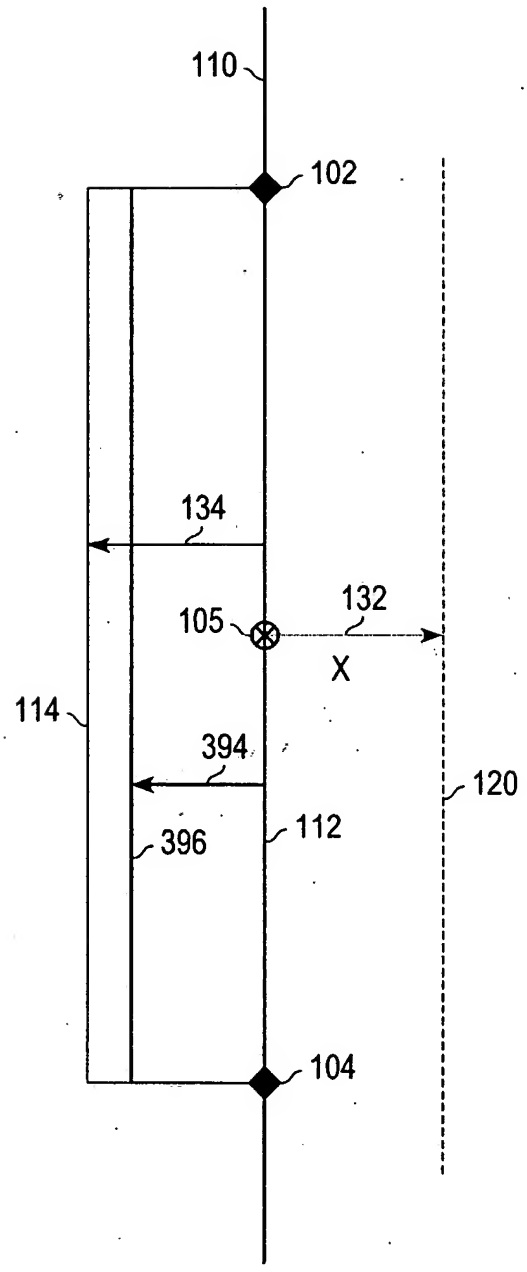


Fig. 3C

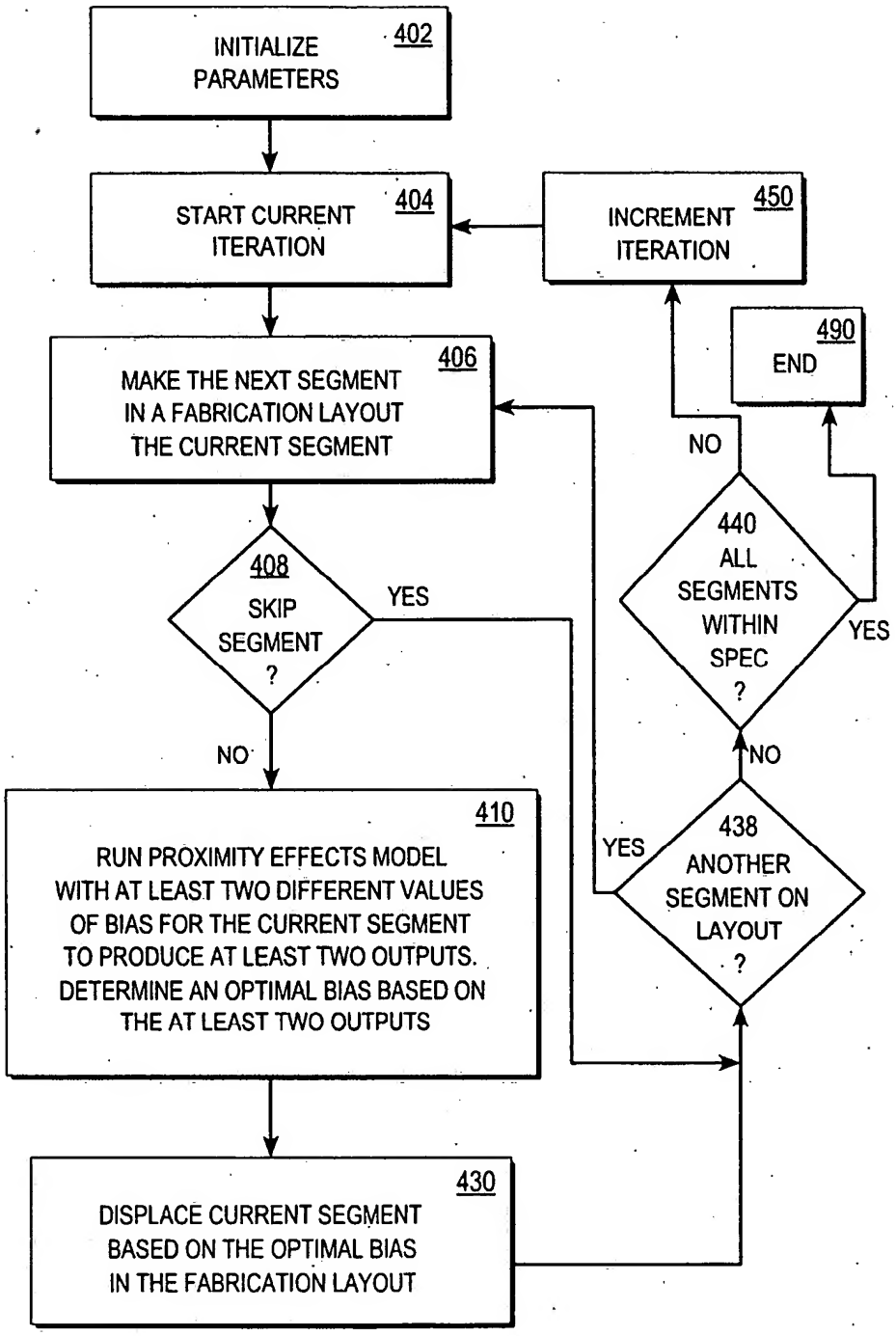

INITIALIZE PARAMETERS
402
START CURRENT ITERATION
404
INCREMENT ITERATION
450
END
490
MAKE THE NEXT SEGMENT IN A FABRICATION LAYOUT THE CURRENT SEGMENT
406
408
SKIP SEGMENT ?
YES
NO
440
ALL SEGMENTS WITHIN SPEC ?
YES
NO
438
ANOTHER SEGMENT ON LAYOUT ?
YES
410
RUN PROXIMITY EFFECTS MODEL WITH AT LEAST TWO DIFFERENT VALUES OF BIAS FOR THE CURRENT SEGMENT TO PRODUCE AT LEAST TWO OUTPUTS. DETERMINE AN OPTIMAL BIAS BASED ON THE AT LEAST TWO OUTPUTS
430
DISPLACE CURRENT SEGMENT BASED ON THE OPTIMAL BIAS IN THE FABRICATION LAYOUT

Fig. 4A

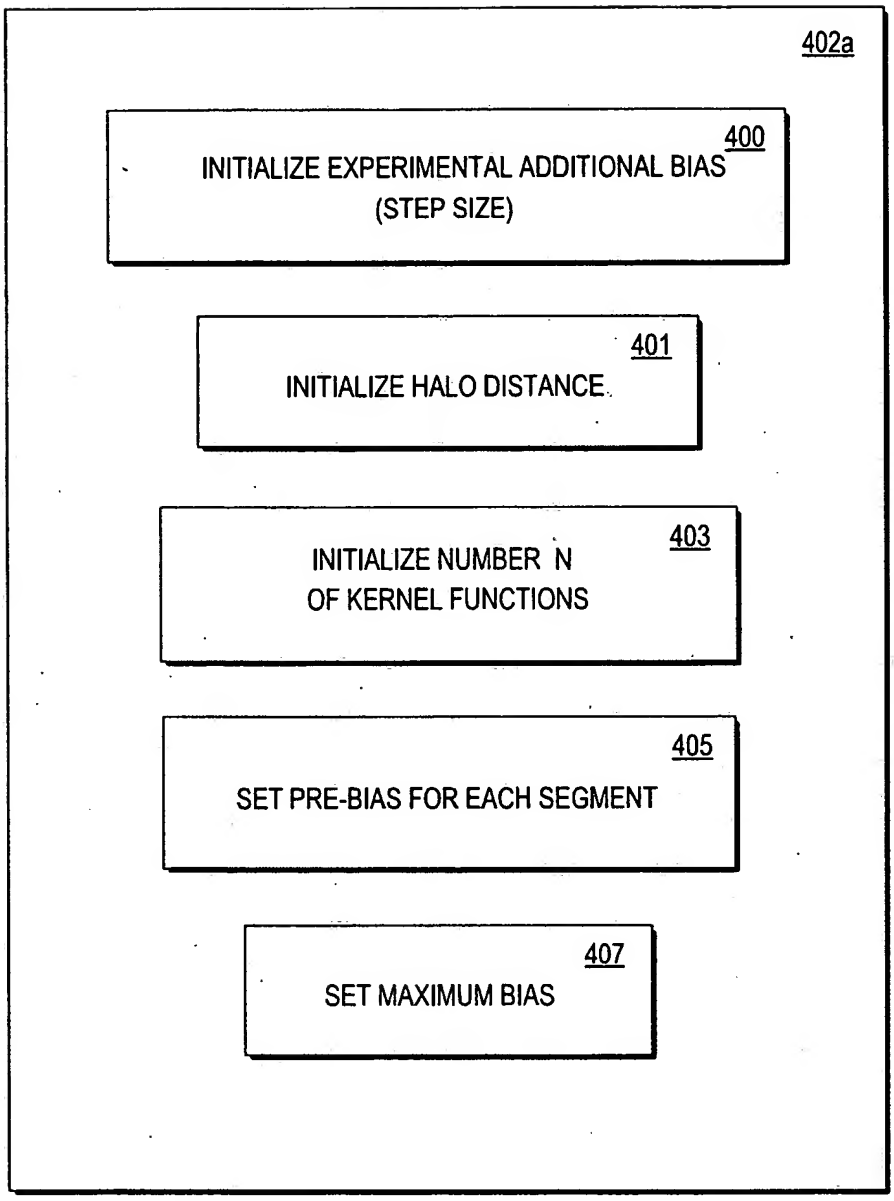

402a
400
INITIALIZE EXPERIMENTAL ADDITIONAL BIAS (STEP SIZE)
401
INITIALIZE HALO DISTANCE
403
INITIALIZE NUMBER N OF KERNEL FUNCTIONS
405
SET PRE-BIAS FOR EACH SEGMENT
407
SET MAXIMUM BIAS

Fig. 4B

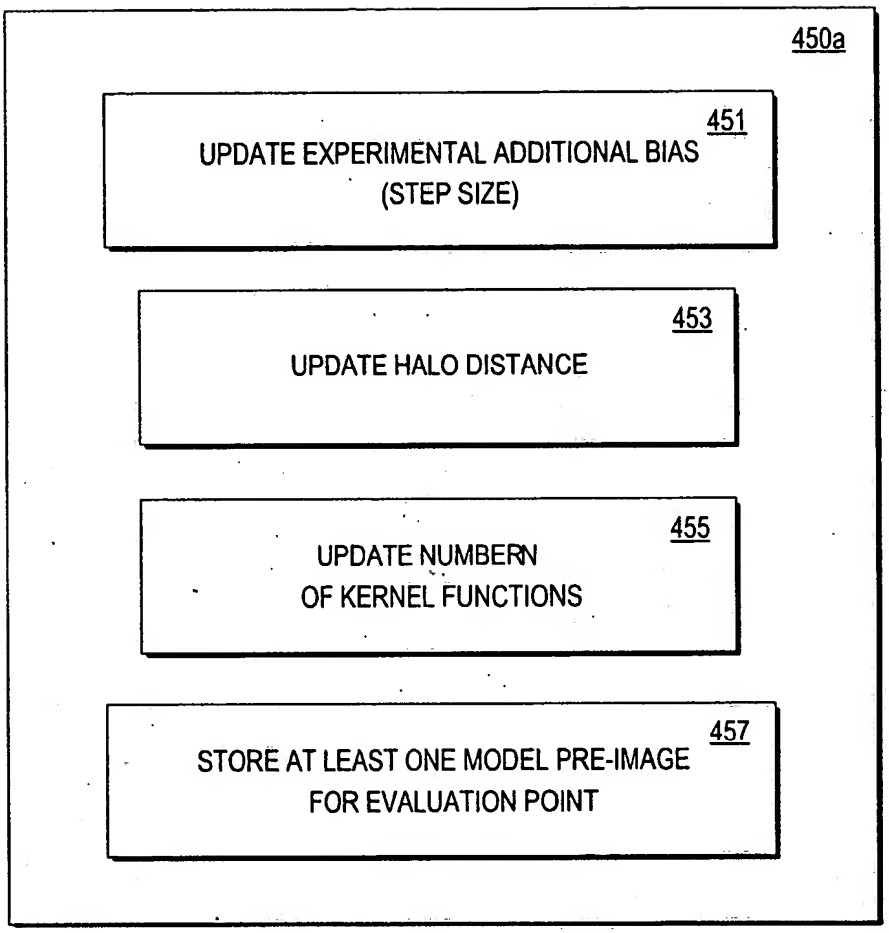

450a
451
UPDATE EXPERIMENTAL ADDITIONAL BIAS (STEP SIZE)
453
UPDATE HALO DISTANCE
455
UPDATE NUMBERN OF KERNEL FUNCTIONS
457
STORE AT LEAST ONE MODEL PRE-IMAGE FOR EVALUATION POINT

Fig. 4C

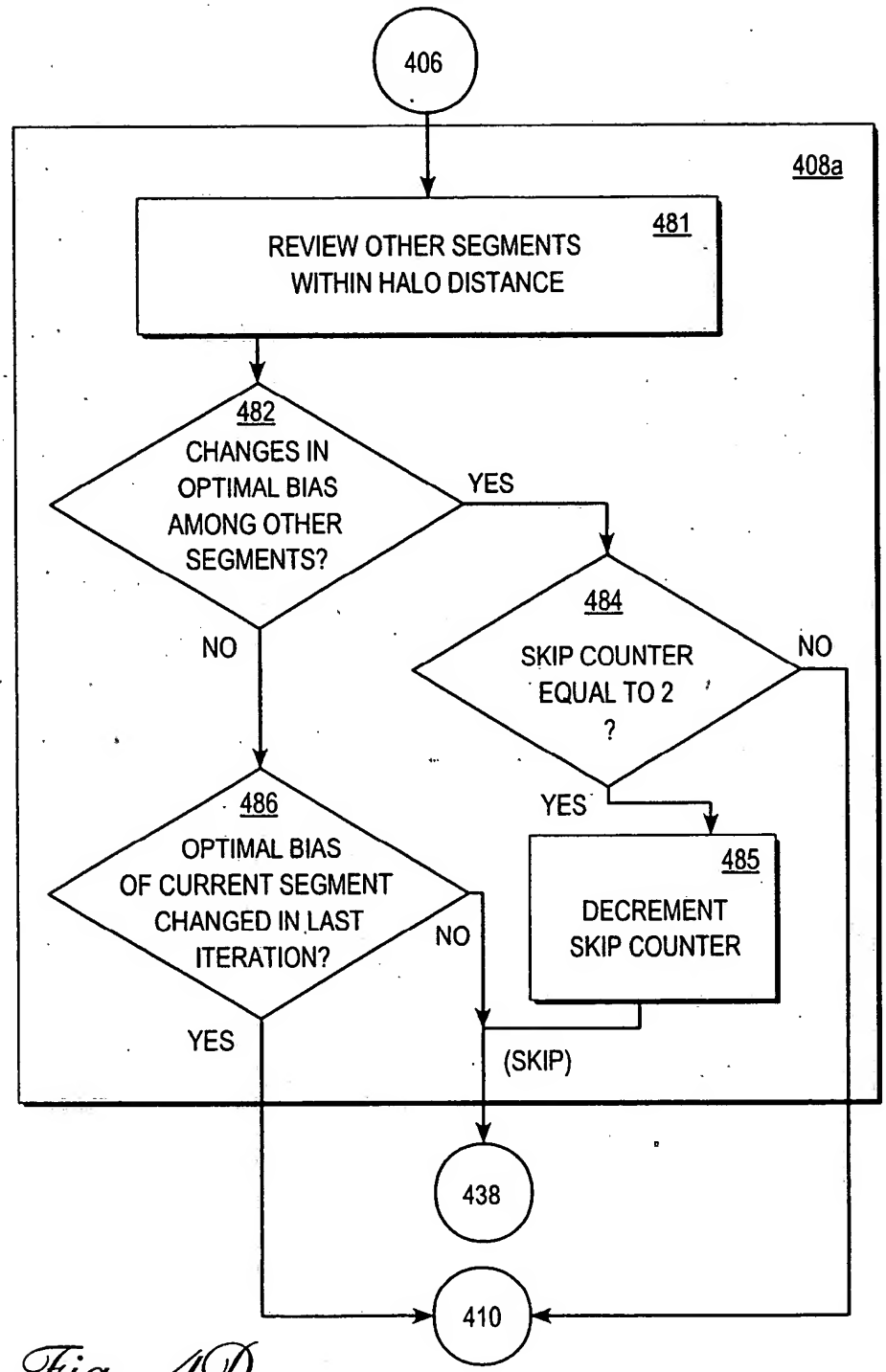

406
408a
481
REVIEW OTHER SEGMENTS WITHIN HALO DISTANCE
482
CHANGES IN OPTIMAL BIAS AMONG OTHER SEGMENTS?
YES
NO
484
SKIP COUNTER EQUAL TO 2 ?
NO
YES
486
OPTIMAL BIAS OF CURRENT SEGMENT CHANGED IN LAST ITERATION?
NO
YES
485
DECREMENT SKIP COUNTER
(SKIP)
438
410

Fig. 4D

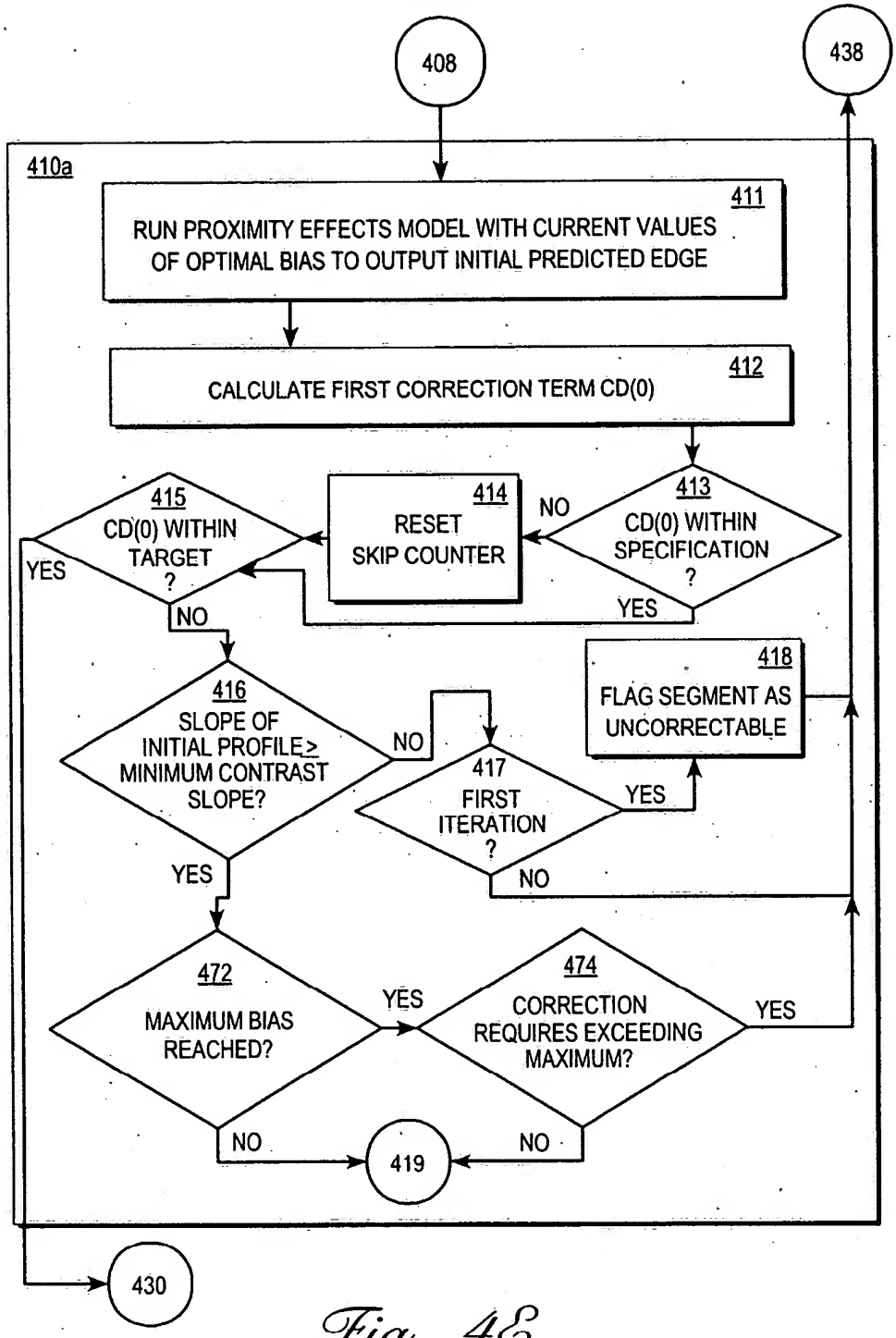

408
438
410a
411
RUN PROXIMITY EFFECTS MODEL WITH CURRENT VALUES OF OPTIMAL BIAS TO OUTPUT INITIAL PREDICTED EDGE
412
CALCULATE FIRST CORRECTION TERM CD(0)
413
CD(0) WITHIN SPECIFICATION ?
NO
414
RESET SKIP COUNTER
415
CD(0) WITHIN TARGET ?
YES
NO
YES
418
FLAG SEGMENT AS UNCORRECTABLE
416
SLOPE OF INITIAL PROFILE> MINIMUM CONTRAST SLOPE?
NO
417
FIRST ITERATION ?
YES
NO
YES
472
MAXIMUM BIAS REACHED?
YES
474
CORRECTION REQUIRES EXCEEDING MAXIMUM?
YES
NO
NO
419
430

Fig. 4E

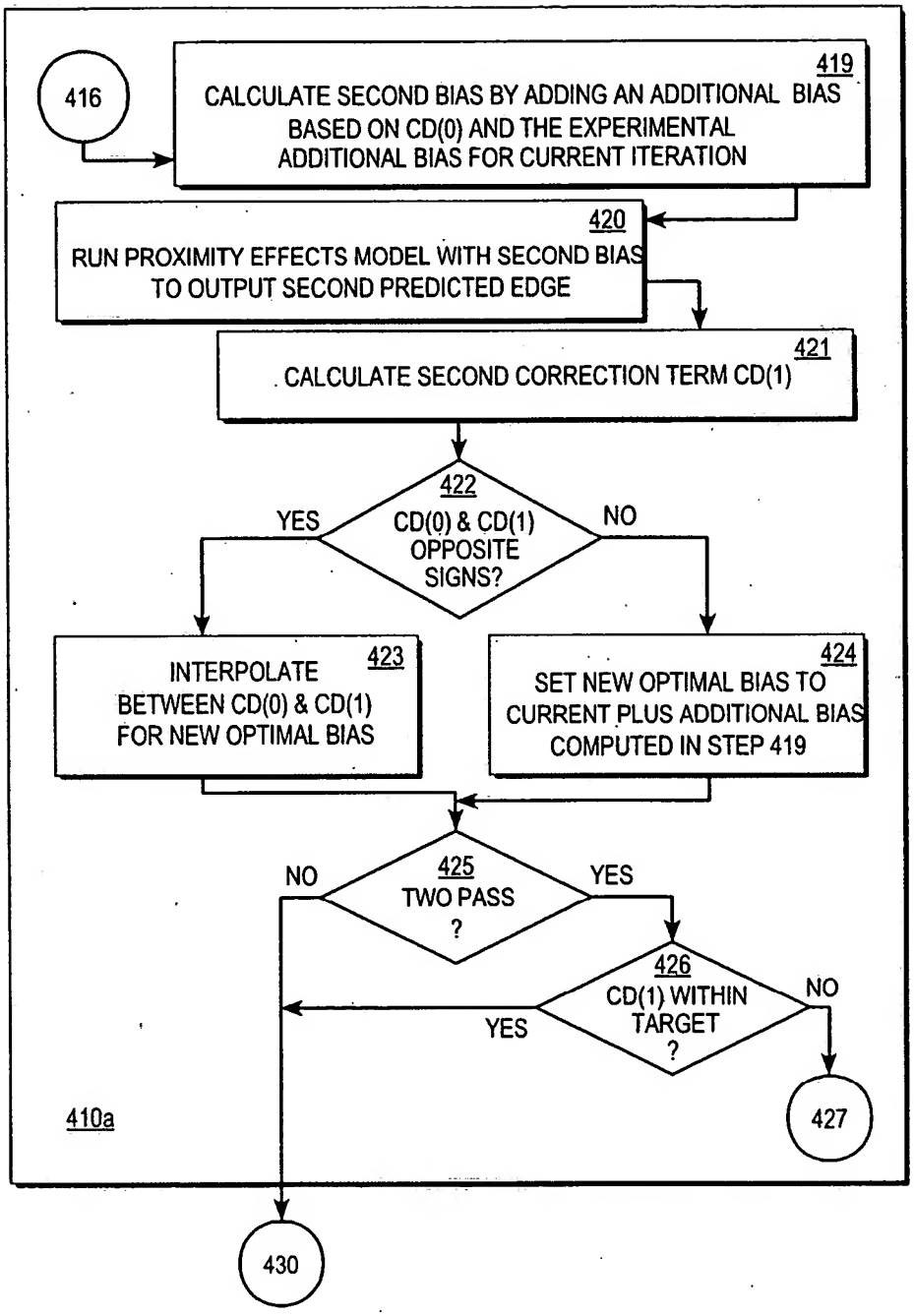

416
419
CALCULATE SECOND BIAS BY ADDING AN ADDITIONAL BIAS BASED ON CD(0) AND THE EXPERIMENTAL ADDITIONAL BIAS FOR CURRENT ITERATION
420
RUN PROXIMITY EFFECTS MODEL WITH SECOND BIAS TO OUTPUT SECOND PREDICTED EDGE
421
CALCULATE SECOND CORRECTION TERM CD(1)
422
CD(0) & CD(1) OPPOSITE SIGNS?
YES
NO
423
INTERPOLATE BETWEEN CD(0) & CD(1) FOR NEW OPTIMAL BIAS
424
SET NEW OPTIMAL BIAS TO CURRENT PLUS ADDITIONAL BIAS COMPUTED IN STEP 419
425
TWO PASS ?
NO
YES
426
CD(1) WITHIN TARGET ?
YES
NO
427
410a
430

Fig. 4F

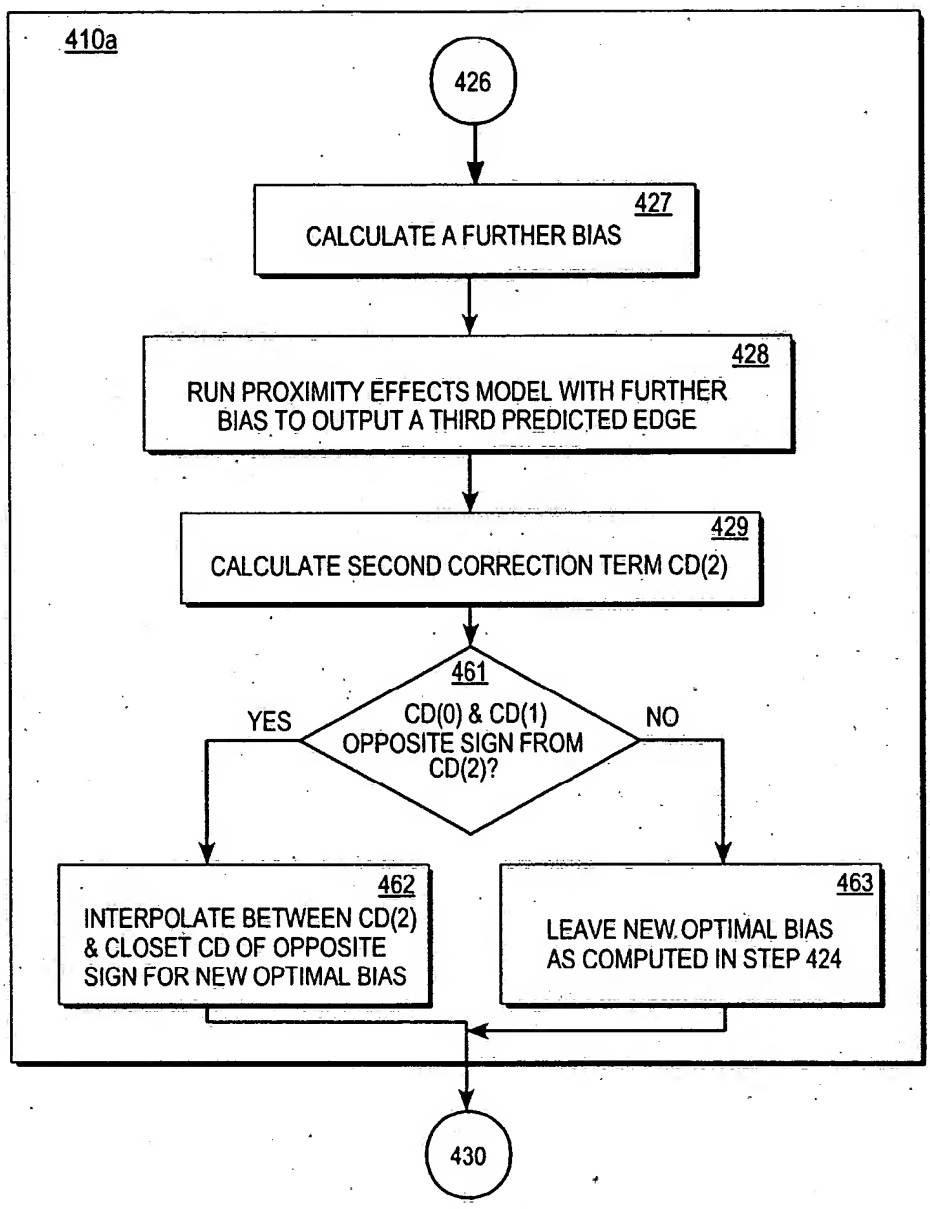

410a
426
427
CALCULATE A FURTHER BIAS
428
RUN PROXIMITY EFFECTS MODEL WITH FURTHER BIAS TO OUTPUT A THIRD PREDICTED EDGE
429
CALCULATE SECOND CORRECTION TERM CD(2)
461
CD(0) & CD(1) OPPOSITE SIGN FROM CD(2)?
YES
NO
462
INTERPOLATE BETWEEN CD(2) & CLOSET CD OF OPPOSITE SIGN FOR NEW OPTIMAL BIAS
463
LEAVE NEW OPTIMAL BIAS AS COMPUTED IN STEP 424
430

Fig. 4G

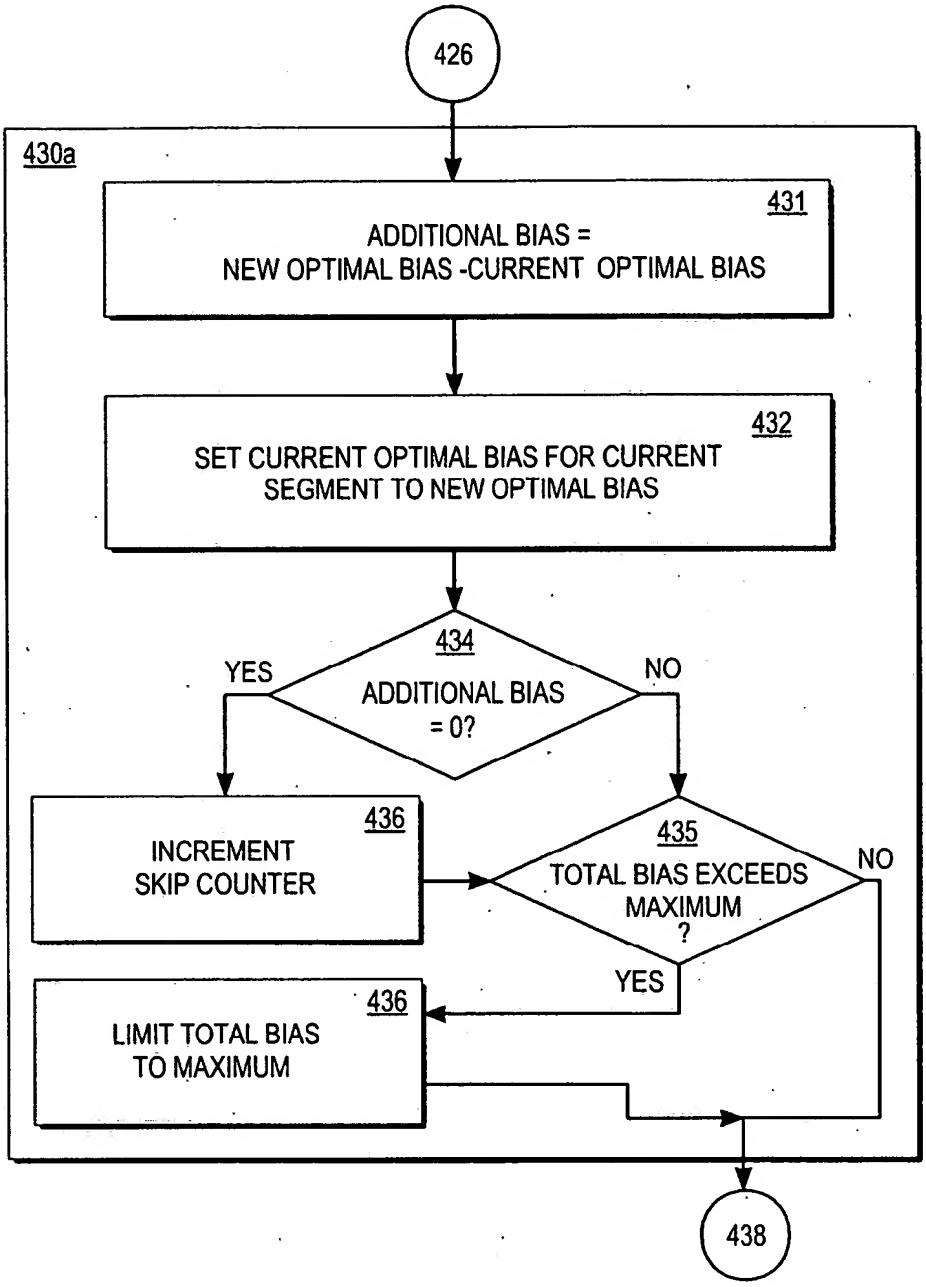

426
430a
431
ADDITIONAL BIAS =
NEW OPTIMAL BIAS -CURRENT OPTIMAL BIAS
432
SET CURRENT OPTIMAL BIAS FOR CURRENT
SEGMENT TO NEW OPTIMAL BIAS
434
ADDITIONAL BIAS
= 0?
YES
NO
436
INCREMENT
SKIP COUNTER
435
TOTAL BIAS EXCEEDS
MAXIMUM
?
NO
YES
436
LIMIT TOTAL BIAS
TO MAXIMUM
438

Fig. 4K

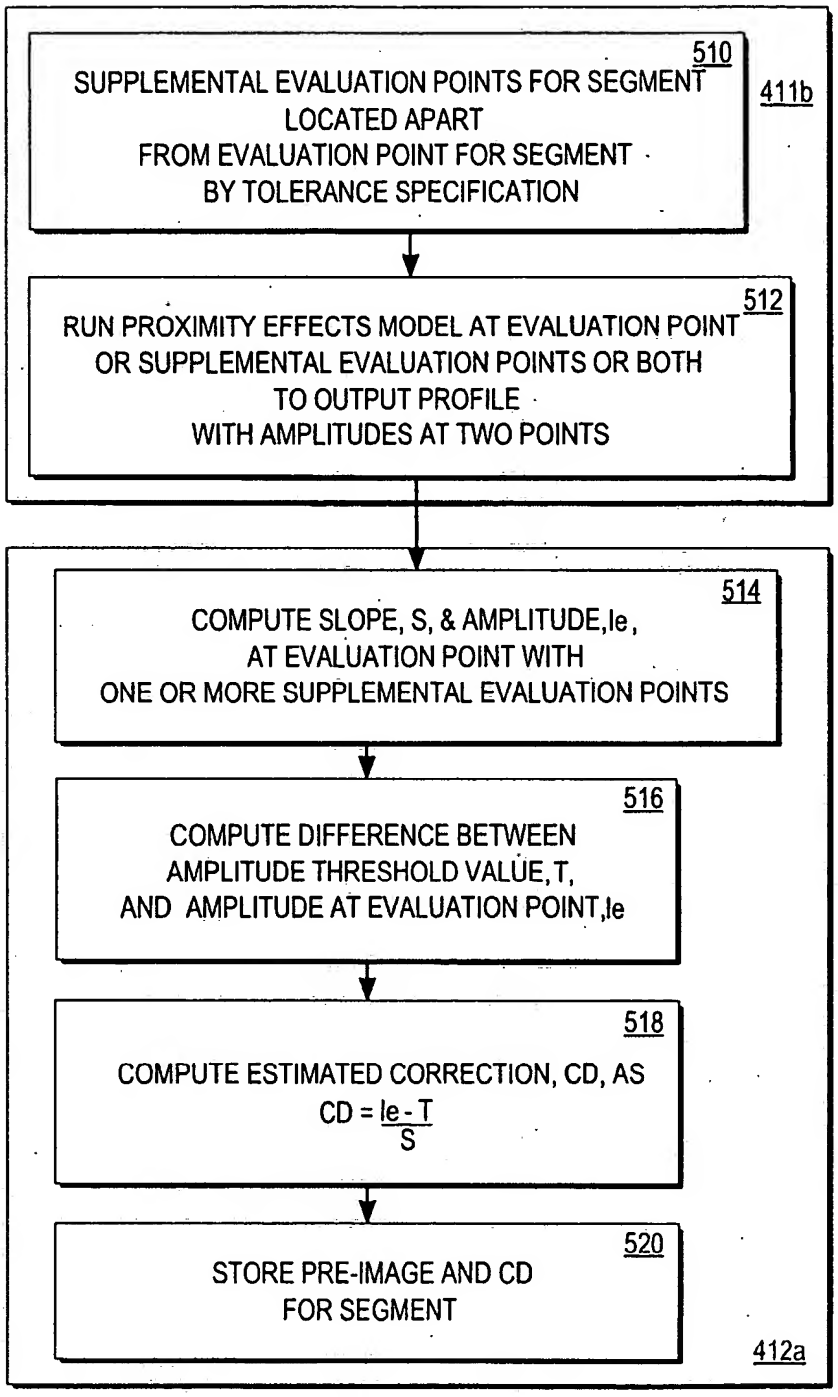

510
SUPPLEMENTAL EVALUATION POINTS FOR SEGMENT LOCATED APART FROM EVALUATION POINT FOR SEGMENT BY TOLERANCE SPECIFICATION
411b
512
RUN PROXIMITY EFFECTS MODEL AT EVALUATION POINT OR SUPPLEMENTAL EVALUATION POINTS OR BOTH TO OUTPUT PROFILE WITH AMPLITUDES AT TWO POINTS
514
COMPUTE SLOPE, S, & AMPLITUDE,Ie, AT EVALUATION POINT WITH ONE OR MORE SUPPLEMENTAL EVALUATION POINTS
516
COMPUTE DIFFERENCE BETWEEN AMPLITUDE THRESHOLD VALUE, T, AND AMPLITUDE AT EVALUATION POINT,Ie
518
COMPUTE ESTIMATED CORRECTION, CD, AS
CD = Ie - T / S
520
STORE PRE-IMAGE AND CD FOR SEGMENT
412a

Fig. 5A

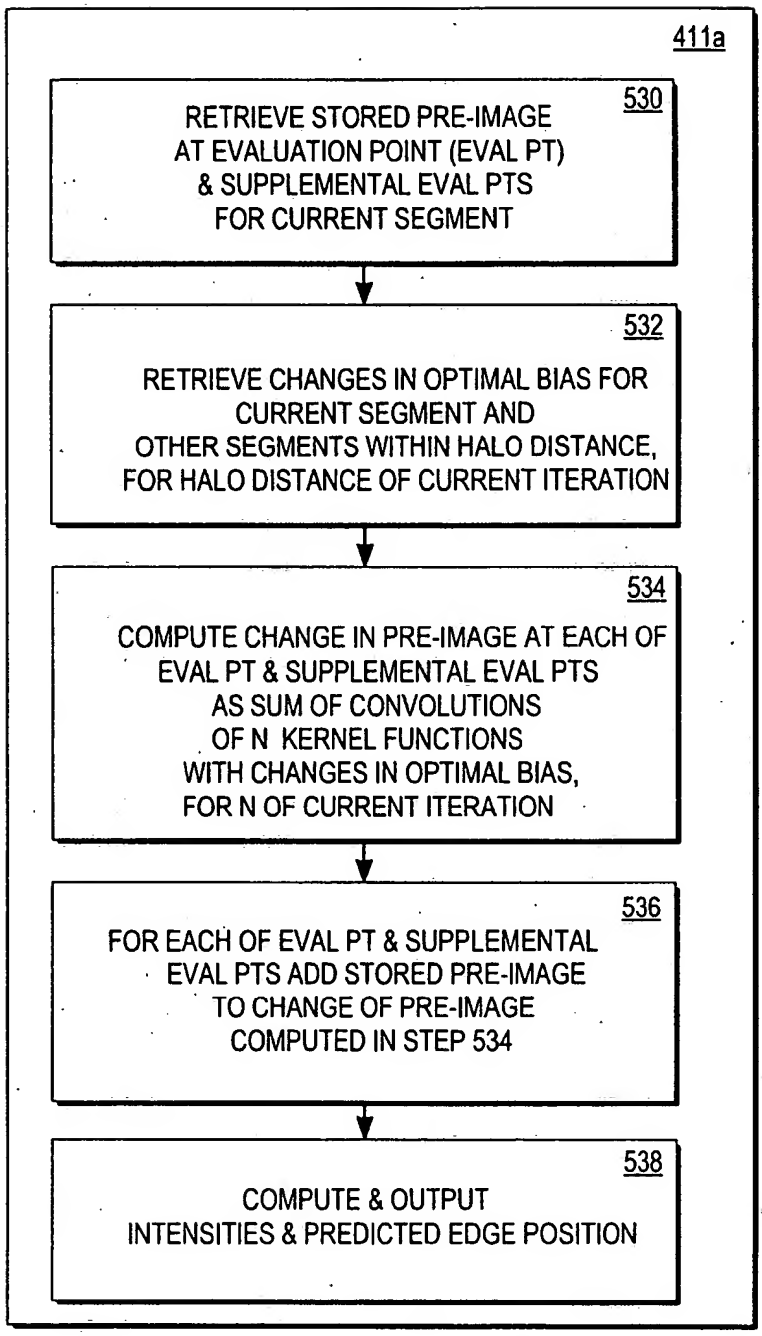

411a
530
RETRIEVE STORED PRE-IMAGE AT EVALUATION POINT (EVAL PT) & SUPPLEMENTAL EVAL PTS FOR CURRENT SEGMENT
532
RETRIEVE CHANGES IN OPTIMAL BIAS FOR CURRENT SEGMENT AND OTHER SEGMENTS WITHIN HALO DISTANCE, FOR HALO DISTANCE OF CURRENT ITERATION
534
COMPUTE CHANGE IN PRE-IMAGE AT EACH OF EVAL PT & SUPPLEMENTAL EVAL PTS AS SUM OF CONVOLUTIONS OF N KERNEL FUNCTIONS WITH CHANGES IN OPTIMAL BIAS, FOR N OF CURRENT ITERATION
536
FOR EACH OF EVAL PT & SUPPLEMENTAL EVAL PTS ADD STORED PRE-IMAGE TO CHANGE OF PRE-IMAGE COMPUTED IN STEP 534
538
COMPUTE & OUTPUT INTENSITIES & PREDICTED EDGE POSITION

Fig. 5B

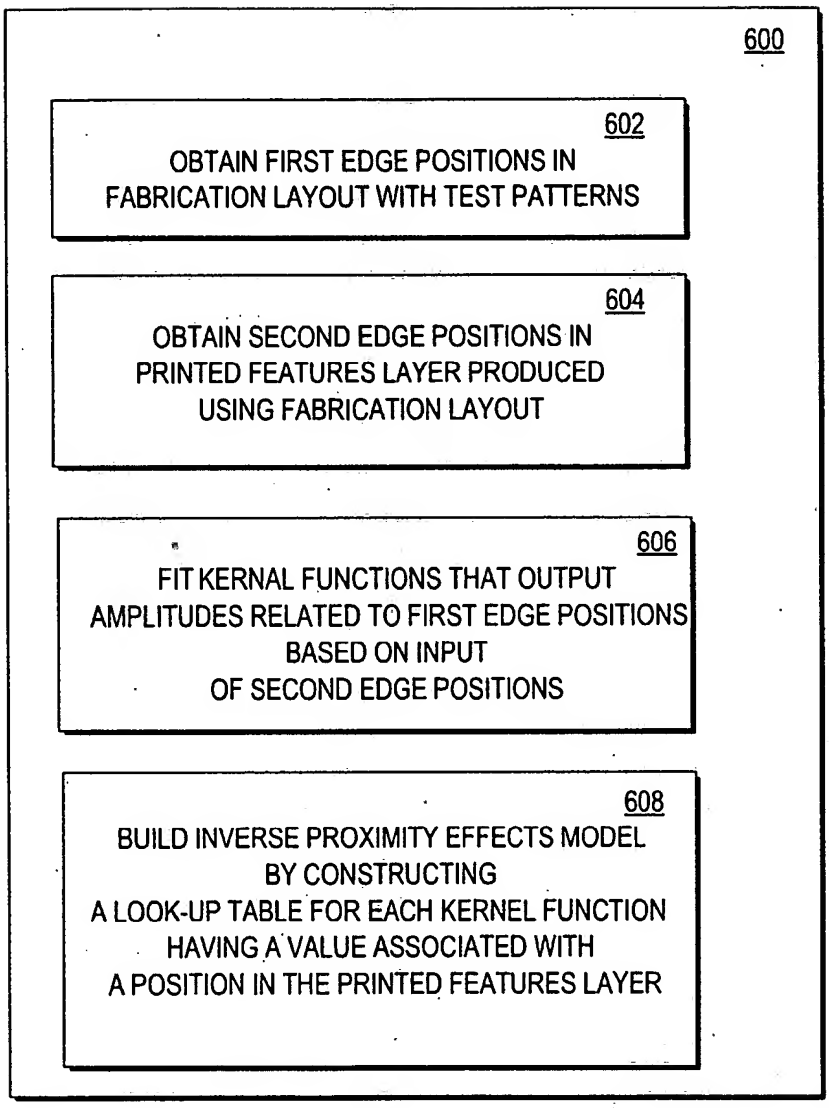

600
602
OBTAIN FIRST EDGE POSITIONS IN FABRICATION LAYOUT WITH TEST PATTERNS
604
OBTAIN SECOND EDGE POSITIONS IN PRINTED FEATURES LAYER PRODUCED USING FABRICATION LAYOUT
606
FIT KERNAL FUNCTIONS THAT OUTPUT AMPLITUDES RELATED TO FIRST EDGE POSITIONS BASED ON INPUT OF SECOND EDGE POSITIONS
608
BUILD INVERSE PROXIMITY EFFECTS MODEL BY CONSTRUCTING A LOOK-UP TABLE FOR EACH KERNEL FUNCTION HAVING A VALUE ASSOCIATED WITH A POSITION IN THE PRINTED FEATURES LAYER

Fig. 6

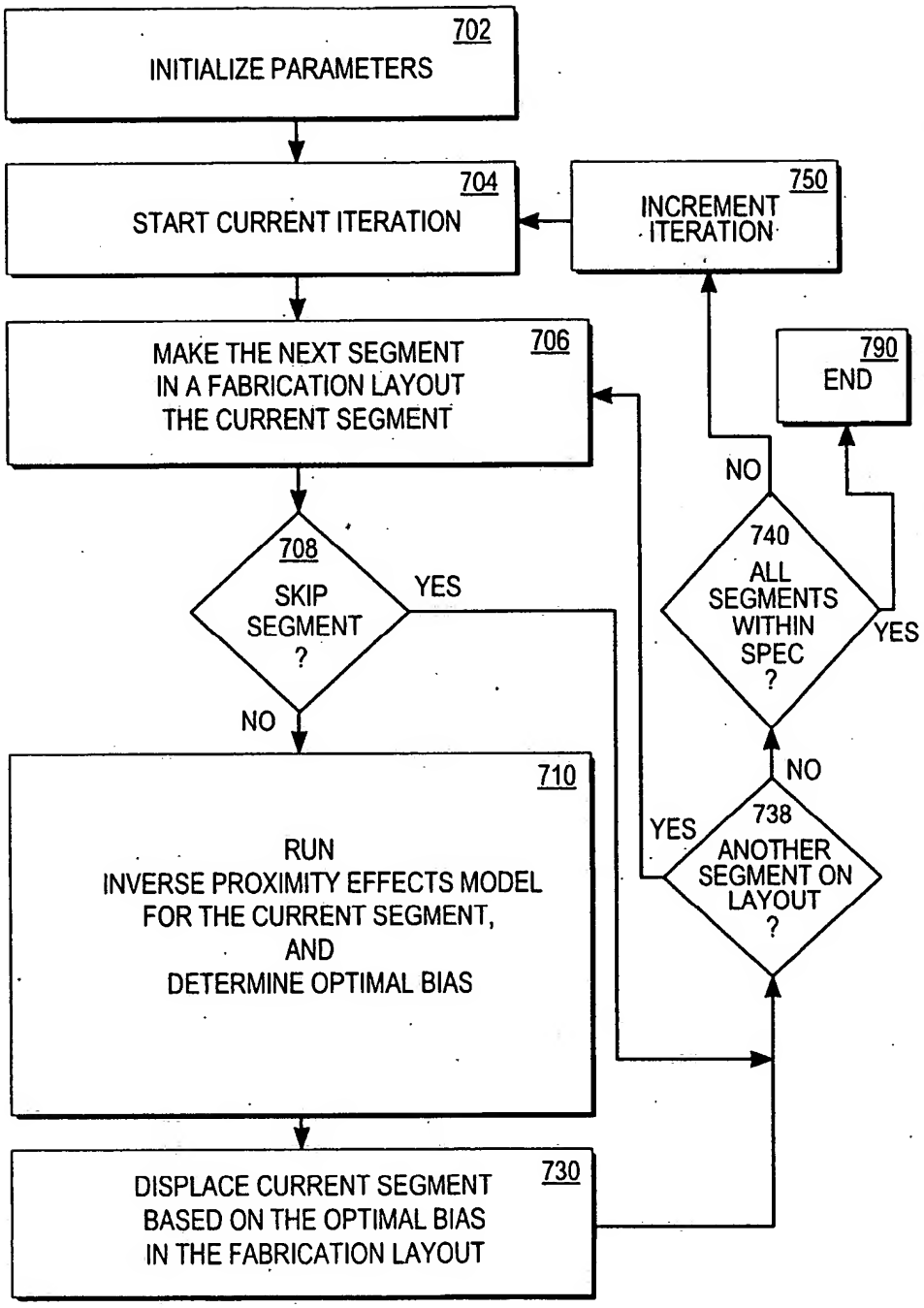

702
INITIALIZE PARAMETERS
704
START CURRENT ITERATION
750
INCREMENT ITERATION
706
MAKE THE NEXT SEGMENT IN A FABRICATION LAYOUT THE CURRENT SEGMENT
790
END
708
SKIP SEGMENT ?
YES
NO
740
ALL SEGMENTS WITHIN SPEC ?
YES
NO
738
ANOTHER SEGMENT ON LAYOUT ?
YES
NO
710
RUN INVERSE PROXIMITY EFFECTS MODEL FOR THE CURRENT SEGMENT, AND DETERMINE OPTIMAL BIAS
730
DISPLACE CURRENT SEGMENT BASED ON THE OPTIMAL BIAS IN THE FABRICATION LAYOUT

Fig. 7

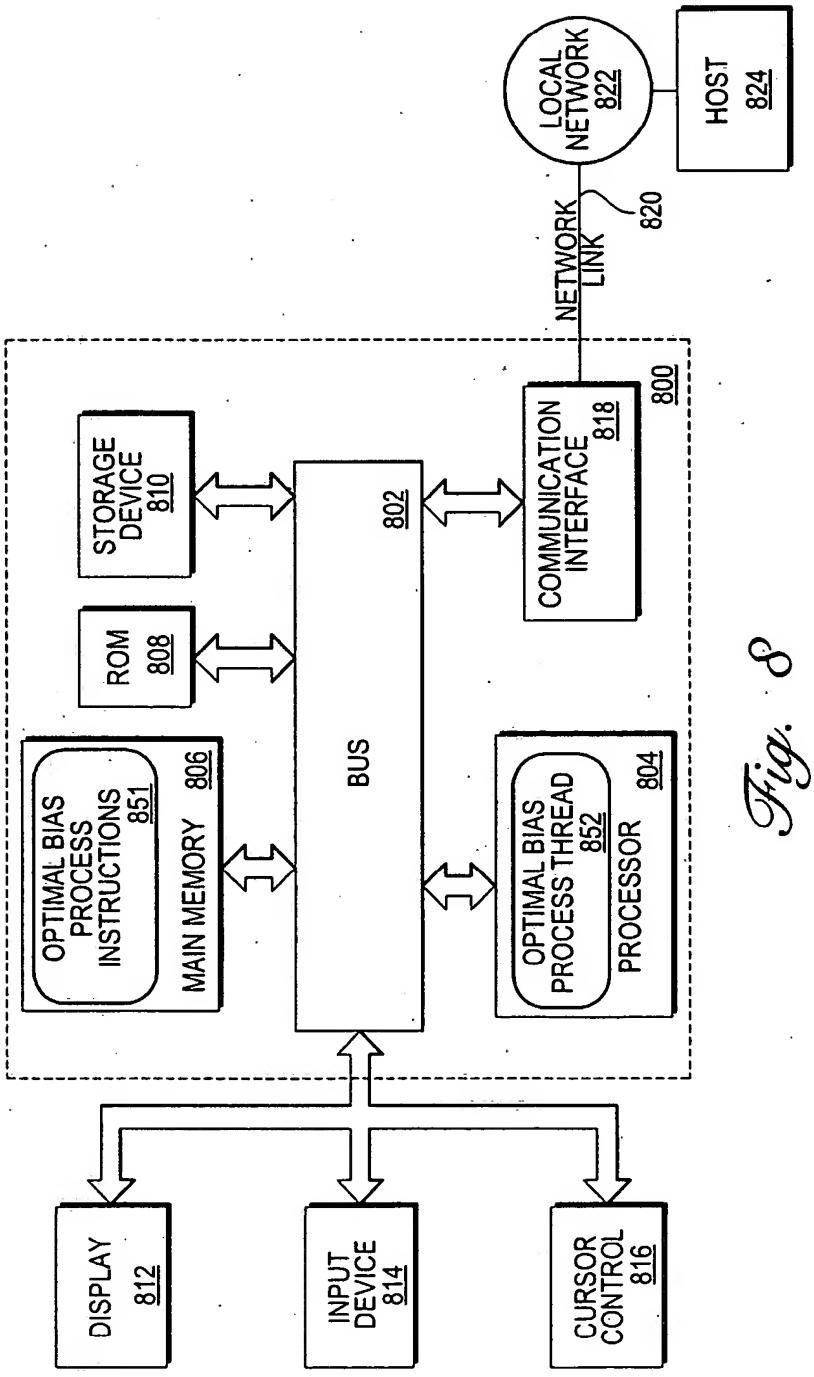
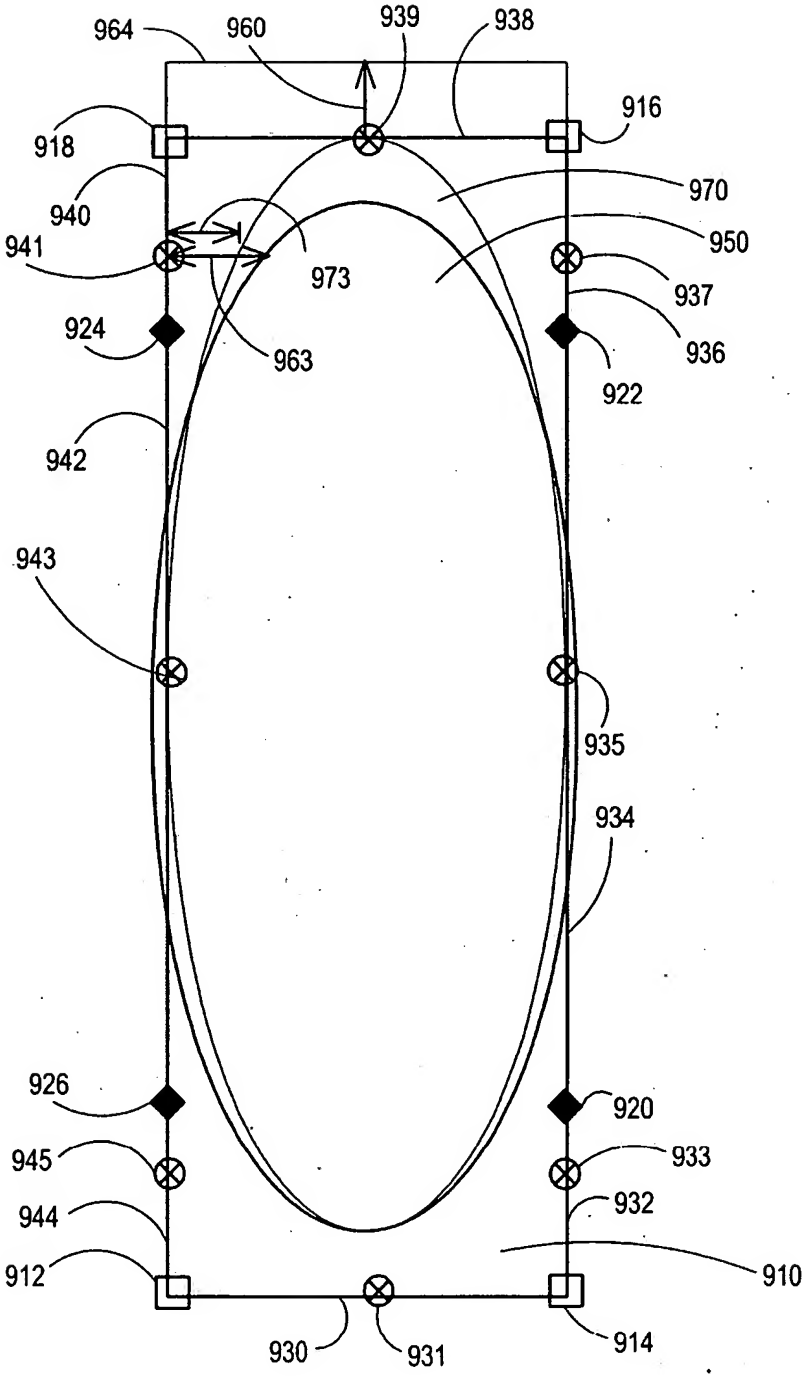

LOCAL NETWORK 822
HOST 824
NETWORK LINK 820
800
COMMUNICATION INTERFACE 818
STORAGE DEVICE 810
ROM 808
BUS 802
OPTIMAL BIAS PROCESS INSTRUCTIONS 851
MAIN MEMORY 806
OPTIMAL BIAS PROCESS THREAD 852
PROCESSOR 804
DISPLAY 812
INPUT DEVICE 814
CURSOR CONTROL 816

Fig. 8


964
960
939
938
916
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970
940
950
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914

Fig. 9